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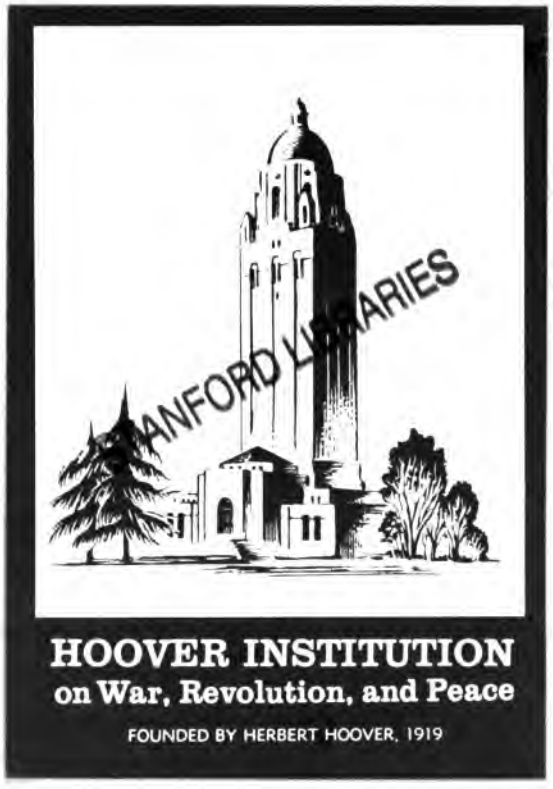

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THE RUBBER INDUSTRY

IN THE

TERRITORIES OF MANICA AND SOFALA

BY

W. H. JOHNSON,

Fellow of the Linnean Society of London; Director of Agriculture to the Moçambique Company; Author of the "Cultivation and Preparation of Para Rubber," and various other Works on Tropical Agriculture; Ex-Director of Agriculture to the Gold Coast Government.

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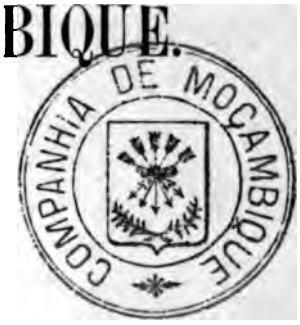

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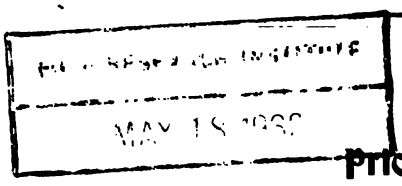

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THE RUBBER INDUSTRY

IN THE

TERRITORIES OF MANICA AND SOFALA,

ADMINISTERED BY

THE MOÇAMBIQUE COMPANY.

The 60,000 square miles of country comprised in the Territories of Manica and Sofala are administered by the Moçambique Company by virtue of a Royal Charter granted by His Majesty the King of Portugal in the year 1891. It is the only Chartered Company now extant governing territory which had been under the direct administration of a European Power previous to its Charter being granted.

The Territories of Manica and Sofala are of especial interest to Great Britain in view of the large amount of British capital invested therein, and of the fact that the City of Beira, the capital, is the natural and therefore the recognised port for Rhodesia.

The boundaries of these Territories are:—The Zambesi on the North, Southern Rhodesia on the West, Inhambane on the South, and the Indian Ocean on the East.

The earliest record of rubber in published writings was made by Gonzalo Fernandès d'Ovièdo Y Valdas, in his "Histoire générale des Indies," published at Madrid in 1536. In this is mentioned the Indians' game of Batey, played with a rubber ball.

It was, however, not until 1736 that the first specimens of this substance arrived in Europe; these La Comdamine despatched under the name *caoutchouc* from Quito, the capital of Ecuador, to the Paris Academy.

Twenty-four years later, Priestly invited attention to the value of indiarubber for erasing lead-pencil marks. In 1823, Mackintosh discovered a method whereby garments could be rendered water-proof by the application of a solution of indiarubber.

Owing to the fact that raw rubber is brittle at low temperatures, and is rendered tacky by high temperature, its present extensive use in the manufactures and arts would never have been realised had it not been for the discovery of vulcanisation, which to a very large extent remedies these natural defects. The year 1839, the date of this discovery by Nelson Goodyear, may therefore be considered the birth of the rubber industry.

The exact date of the discovery of rubber-producing plants in the Moçambique Company's Territory is not known, but exports of rubber were made by Indian merchants long before the Company received its Charter.

SOURCES OF RUBBER IN MANICA AND SOFALA.

Landolphia Kirkii Dyer, until quite recently, the only indigenous plant exploited for rubber in these Territories, was first discovered by Sir John Kirk, in Zanzibar about thirty years ago, and it is considered probable that it was found and exploited in Manica and Sofala very shortly afterwards.

This plant is practically ubiquitous in these Territories. The writer has observed it growing within a few yards of the seashore and at all elevations up to 4,000 feet. Its habit is, however, profoundly altered by the different climatic and other conditions obtained in these various districts.

In the dry areas of the low country it assumes a low-growing, straggly, and at times almost shrubby habit. The leaves, flowers, and fruits which it produces in these regions being much smaller than those of plants growing at higher elevations and in regions where the rainfall is more abundant. In the latter districts, *Landolphia Kirkii* develops into an enormous vine with tappable stems often more than a hundred feet in length, its foliage being displayed in the sunlight intermingled with that of gigantic forest trees.

The stems of such vines frequently attain a diameter of 10 to 12 inches, whereas those of plants growing in the Low country rarely exceed a diameter of six inches.

The flowers are small, white, salver-shaped, and fragrant, arranged in dense corymbs; they are, however, frequently aborted into straggly tendrils.

The fruits vary in shape, even on the same plant, from spherical to pyriform, and in size from one to three inches in diameter.

The seeds are horny, angular, and, in mature fruits, covered with yellow mucilage.

The leaves are small, lanceolate, a glossy bright green above but a paler green beneath, with dense brown pubescence on the prominent mid-rib.

This latter character is also very conspicuous on the young stems, but vanishes with age when numerous small pale yellow excrescences appear.

The bark of old stems is often half-an-inch in thickness, and has a pale brown corrugated appearance on the surface.

The latex produced by this plant is white, thick, rich in caoutchouc, and it rapidly coagulates on exposure to the atmosphere.

The newly coagulated product is pure white, but changes to a pale amber colour on drying. It possesses excellent physical properties, and the following analysis, made of fair samples at the Imperial Institute, London, demonstrates both its high caoutchouc content and freedom from deleterious impurities :—

	Sample as received.	Composition of dry rubber.
Moisture	5·0	... ...
Caoutchouc	85·6	... ... 90·1
Resin	5·5	... ... 5·7
Proteids	1·3	... ... 1·3
Insoluble	2·7	... ... 2·8
Ash	0·46	... ... 0·48

This rubber, when properly prepared, is always in good demand, and realises prices only slightly inferior to " Fine Para."

The following sources of rubber, new to these Territories, have been recently discovered by the researches of the Technical Department :—

Mascarenhasia Elastica K. Sch : var. Authorities at the Royal Botanic Gardens, Kew, who have compared botanical specimens of this plant with those of *Mascarenhasia Elastica K. Sch.* in the Kew Herbarium, state that it differs from the latter in having obtuse instead of obtusely-acuminate leaves, and also in having follicles with more or less incurved tips.

This new source of rubber is a shrubby tree varying in height from 20 to 30 feet. It produces bright, dark-green foliage, the leaves vary from three to nine inches in length, and in breadth from one to two inches.

To the casual observer its white fragrant flowers are somewhat similar in form to, though more than three times as large as, those of *Landolphia Kirkii Dyer*. They are produced in few flowered cymes situated in the axils of the leaves.

The latex produced by this tree is also white and thick and rapidly coagulates on exposure to the atmosphere. The resultant rubber, although slightly inferior in quality to that yielded by *Landolphia Kirkii*, exhibits excellent physical properties.

Investigations conducted by the Company's administrative officials show that this tree is abundant in several districts in these Territories, and steps are being taken to test its productive capacity.

Landolphia sp. near L. Buchananii, Stapf. Botanical specimens of a second new rubber-producing plant, which were submitted to the Royal Botanical Gardens, Kew, for identification, were found to resemble closely those of *Landolphia Buchananii, Stapf.*

The general habit of this plant resembles that of *Landolphia Kirkii*, and the quality of the rubber produced by both plants appears to be very similar.

It has not yet been ascertained to what extent this new source of rubber occurs in Manica and Sofala.

Landolphia Florida Benth. This well-known tropical liane abounds in several districts.

Widely diverse opinions have been expressed in regard to the economic value of this plant. Extensive researches, conducted by the writer in West Africa, completely failed to produce a substance of commercial value from its latex. It is, therefore, somewhat surprising that latex collected from lianes of this species growing in Manica and Sofala, and treated by one of the processes, *i.e.*, ebullition, which in West Africa failed to give satisfactory results, has yielded what it is expected will prove a marketable commodity.

The physical properties of this product are poor, and a chemical examination will probably show a low caoutchouc content. Still, it is considered that it compares favourably with several medium grade rubbers which find a profitable market.

Ficus Vogetii, Mig: is usually a huge epiphyte. It is closely allied and similar in habit to the Indian rubber tree, which yields the product known in commerce as "Rambong Rubber."

Samples of rubber, collected by the writer from this tree in West Africa, had poor physical properties, being lacking in resiliency and tenacity. On examination at the Imperial Institute they were found to contain 44 per cent. of resinous matter and only about 51 per cent. of caoutchouc.

As this tree is fairly abundant in Manica and Sofala, and yields a large amount of latex, it is quite possible that it might be profitably exploited, as the samples of rubber previously referred to were valued by London brokers at 2s. per lb.

Diplorhynchus Mossambicensis, Benth: is one of the commonest plants in these territories. It forms a small sturdy tree which, on being tapped, yields a large amount of latex.

A guttapercha-like substance has been obtained from the latax by ebullition; but its commercial value has not yet been ascertained.

Regulations affecting Rubber Collection.

Numerous laws have been, from time to time, promulgated, mainly with the view of preventing the surreptitious collection of rubber and conserving the plants which produce this product.

The Moçambique Company does not monopolise the collection of rubber, but allocates the rubber forests, in certain districts, to private enterprise, and reserves others for its own exploitation.

To avoid the destruction of plants by over-tapping, rubber collection is prohibited in certain regions when it is considered that the plants therein require a period of rest for recuperation.

The conservation of rubber-yielding plants is still further provided for by restricting the period of collection and trading of rubber from the 15th February to the 31st August of each year.

Persons desirous of collecting or trading rubber in any of the districts open to the public must provide themselves with a license costing £12, which is untransferable and only available for a year in the district indicated thereon. Each kilo of rubber, obtained by virtue of this license, is subject to a tax of 250 reis per kilo (6d. per lb.). An export tax of 8 per cent. *ad valorem* is also charged on such rubber.

A license holder is compelled to keep a daily record of the amount of rubber obtained, and to send a monthly statement showing the total amount received during each month, to the Commandant of the district in which he is conducting his operations.

The Collection of Rubber.

The difficulties attending the supervision of the collection of wild rubber from vines, scattered about in the dense forest or amongst thorn bushes, can only be fully appreciated by those personally acquainted with the conditions under which these plants grow.

The native collector is as much an adept in evading the thorns as the eyes of his overseer, and he passes with facility through the mass of dense, tangled, thorn-laden vegetation which is quite impenetrable by a white man.

When we consider that, the collection of rubber in Manica and Sofala has been in progress for nearly thirty years, and the exports of rubber to-day are considerably greater than those of 14 years ago (the earliest date from which records are available), we are compelled to doubt whether the extermination of the sources of wild rubber is as imminent as the promoters of plantation rubber companies would have us believe.

The annual exports of rubber from these Territories since 1894 were as follows :—

1894	... ...	43,858·7 lbs.
1895	... ...	27,812·4 „
1896	... ...	60,577·0 „
1897	... ...	21,676·6 „
1898	... ...	48,661·8 „
1899	... ...	148,570·4 „
1900	... ...	82,141·4 „
1901	... ...	182,516·4 „
1902	... ...	134,813·8 „
1903	... ...	133,988·8 „
1904	... ...	199,126·4 ,
1904	... ...	214,500·0 „
1906	... ...	186,135·0 „
1907	... ...	95,020·0 „
1908	January to June	68,200·0 „

These figures amply demonstrate both the immense vitality of *Landolphia Kirkii* and the advantages accruing from the measures taken to conserve it.

As has been previously pointed out, it is impossible to prevent a certain amount of injury to the vines by the tappers, but there is every indication that this is being yearly diminished by the introduction of more scientific tapping-methods.

The system, which at one time obtained, of cutting up the vines into short pieces for the purpose of extracting the latex is now quite abolished. That which is now generally employed consists in cutting off slices of bark from the mature stems. Providing these incisions be not made unnecessarily long or deep, nor too close together, this system of tapping cannot be considered drastic, and is certainly far less injurious than many methods in vogue in other parts of Africa.

As the majority of the laticiferous vessels traverse the bark of Landolphia Kirkii in a longitudinal direction, a transverse incision obviously taps more vessels than a longitudinal one of the same length. Measures are, therefore, being taken with a view of introducing a system of tapping by means of transverse incisions in order to reduce to a minimum any injury caused to vines by the excision of bark.

The straggly climbing habit of this plant does not allow of the adoption of methods of tapping and collecting the latex, similar to those employed on modern rubber plantations.

Its latex is very thick, and consequently does not flow so readily as that of Hevea and similar plants. Any which is likely to run off the vine on to the ground from a tapping incision is wiped off by the tappers and smeared over their bodies. Both the latter and that left on the vine rapidly coagulates and is wound off by the tappers into small balls or spindles.

The collection of rubber from forest vines requires a large amount of agility and dexterity, for many of them are suspended from the branches of huge forest trees.

The wily native at one time adulterated his rubber by winding it around pieces of stone, lead, dirt, etc., but this practice is now abolished,

as small balls or spindles are demanded which are cut open on receipt. This process likewise expedites the drying of the rubber which is at present effected in open sheds without the aid of artificial heat.

The rubber is packed for export in sacks which contain about 110 pounds.

Experiments have been conducted by the writer with the view of improving the quality and keeping properties of the rubber by exposing it to the smoke given off by fires fed with wood.

Samples of rubber prepared in this manner and similar ones taken from the same collection, but dried by the ordinary method, were submitted for valuation to London rubber brokers.

The smoked samples were rated at 4s. to 4s. 1d. per lb., and the unsmoked samples at 3s. 11d. to 4s. per lb., when Fine Para was selling at 4s. 2d. per lb.

In their report upon this subject the brokers state that the smoked samples were slightly improved both in quality and appearance by the process, as it gave them a brighter look and appeared to increase their elasticity.

There is always an abundance of wood-fuel available in the rubber districts, and, as the period of drying is considerably curtailed when the smoking method is adopted, it is considered that it might be generally employed with advantage.

Natural Regeneration and Propagation.

Landolphia Kirkii is widely disseminated by the aid of animals, which feed on the sweet mucilaginous substance that envelops the seeds.

The latter are generally swallowed whole and are ejected in the animals' excreta. This process appears in no way to impair their germinating properties, as little groups of seedlings are frequently met with growing out of animals' dung.

Seeds in mature fruits, which fall to the ground, often commence to germinate before the fruit-wall decomposes. When disintegration occurs their roots enter the soil and growth continues unchecked.

Thousands of young seedlings may often be seen growing in the neighbourhood of old vines where other vegetation does not produce a dense shade. In thick forest, however, comparatively few of the plants appear to develop beyond the seedling stage owing, probably, to the absence of sufficient light.

In such areas the vines frequently produce aerial roots and many instances have been observed where these have reached the ground and aided propagation.

The Moçambique Company has expended considerable sums of money with the object of increasing the stock of plants in its own reserves. Many thousands of seeds and young plants have been planted, and efforts have been made to assist the natural methods of propagation in the forest by layering the vines.

Rubber Cultivation in Manica and Sofala.

All the principal rubber producing trees, which have given the most satisfactory results under cultivation, have been introduced into Manica and Sofala. The Ceará rubber tree is, however, the only one which is of sufficient age to be tapped.

The following remarks are taken from a report on this tree which appeared in the Imperial Institute Bulletin, 1907, Vol. V., pp. 401—422.

HISTORY OF THE CEARÁ RUBBER TREE.

Manihot Glaziovii, Muell. Arg., the tree which produces the rubber known in commerce as Ceará, or Maniçoba, was exploited in Brazil for a considerable period before it was botanically identified.

It was discovered by Dr. Glaziow, a French botanist, in the neighbourhood of Rio de Janeiro, Brazil, and was described, and named after him, by Mueller in Martius' *Flora Brasiliensis* (XI., Part ii., p. 443), in 1874.

The plant was introduced into various Botanic Gardens as a species of the genus *Hevea*, to which the well-known Pará rubber tree belongs, with which it is still occasionally confused.

Although some seventy species of *Manihot* are said to occur in Brazil, it was generally stated until quite recently that *M. Glaziovii* alone yielded rubber of commercial value, but it now transpires that a distinct species is being cultivated in South America. The latter plant appears to be well known in Sao Paulo, South Brazil, but it has not been botanically identified, nor is it known how the rubber which it produces compares with that yielded by *M. Glaziovii*.

As early as 1876 Cross, who had been commissioned by the Indian Government to visit South America for the purpose of collecting seeds and plants of rubber-producing trees, obtained in a district about thirty miles inland from the town of Ceará some sixty plants and seven hundred seeds

of *M. Glaziovii* (*Selected Papers from Kew Bulletin*, III. "Rubber," p. 118). These were dispatched to the Royal Botanic Gardens, Kew, where during the following two years they were propagated and distributed to various botanical establishments in different countries, including India, the Straits Settlements, Ceylon, Dominica, Fiji, Jamaica, Java, Trinidad, Queensland, and Zanzibar.

To-day the Ceará tree may be found in nearly every tropical and sub-tropical country in the world.

DESCRIPTION OF MANIHOT GLAZIOVII.

Manihot Glaziovii is a medium-sized tree, varying in height from 40 to 50 feet, with an erect trunk frequently 20 inches in diameter.

Some trees produce few erect branches, whilst others have numerous spreading branches.

The leaves are alternate, palmate, and often have petioles longer than the width of the leaf; they are thin in texture, of pale-green colour, smooth on both surfaces, and frequently coated with a white waxy floury substance. The leaves vary considerably in size even on the same tree, and also in the number of lobes, of which from three to nine may be found.

The flowers are large, the floral envelope being thick and fleshy; they are unisexual, with male and female flowers in the same semi-pendulous panicle.

The fruit is a hard, dry capsule divided into three sections, with one seed in each. They are usually larger than, but otherwise similar in form to, those of the castor-oil plant.

The seeds, which are ejected spontaneously and often with considerable force when the capsule dehisces, are plano-convex, about half an inch long by one-third of an inch wide, and have a hard, thick, shiny testa or seed coat. The latter varies in colour from light brown to dark mahogany, and is often marked with blackish blotches, which are more noticeable in the lighter-coloured seeds.

The outer bark of the trunk and old branches is thin, and scales off similarly to that of the birch, but is darker grey in colour. The bark of young trees is frequently tinged with maroon.

Both young and old Ceará trees have enlarged edible roots similar to those of *Manihot utilissima*, the Cassava or Manioca plant.

In its native habitat, which is on the verge of the great central table-land in the north-east of Brazil, the tree appears to flourish in poor, sandy, and stony soil, and at all elevations from sea-level to 3,500 feet (*loc. cit.*, p. 130). The climate of this region is said to be dry and hot from June to December, but the statements made by different travellers respecting the annual rainfall seem to vary in a most extraordinary manner from 50 to 100 inches.

The tree is hardy, grows rapidly, and frequently commences to produce seeds when only two years of age.

In Brazil tapping is said to commence when the tree is five to six years old, at which age it has developed a trunk 8 or 9 inches in diameter (*loc. cit.* p. 130).

The rubber obtained from the Ceará tree is exported from Brazil in three different forms. The first is extracted by peeling off the external thin layer of bark to a height of about 6 feet, and making incisions in the exposed bark with a small axe having a narrow cutting edge. The latex which exudes coagulates naturally for the most part on the trunk in the form of tears or threads, any that flows to the ground being collected on leaves, etc., placed around the base of the tree, and as soon as the rubber has solidified sufficiently it is rolled into balls. These, when packed soon after collection, agglutinate into blocks, which often weigh from 2 to 3 cwt. The rubber is of dark amber colour, and frequently emits a most nauseating smell. This form is known in commerce as " Ceará Scrap."

The second form is obtained by tapping the trunk and allowing the latex to trickle down to the ground, where it coagulates into cakes of various sizes and thicknesses, which are largely contaminated with dirt.

The third form is prepared in a similiar manner to Brazilian Pará rubber, by making gashes in the bark with a small axe and collecting the latex which exudes in small cups. The rubber is prepared by dipping a paddle or similar implement in the latex, and subjecting it to the smoke given off by burning palm nuts.

RESULTS OBTAINED FROM CULTIVATED CEARÁ TREES IN VARIOUS COUNTRIES.

Although Ceará rubber trees have been largely planted in various parts of South America for many years, authentic records of the amount of rubber obtained from them do not appear to be available.

Few economic plants have been so extensively distributed to different portions of the globe as *M. Glaziovii*. This is probably largely due to the fact that the germinating power of the seeds is not so fugitive as that of many other kinds, so that they travel well, and perhaps in a less degree to the hardy nature of the tree.

It does not appear, however, that any large plantation has yet given really satisfactory returns continuously, although there seems every probability that better accounts will be forthcoming from some of the Ceylon and Indian plantations at no very distant date.

The Ceará tree was introduced into Ceylon in 1877 (*Kew Report*, 1877, p. 16), and within a few years large numbers of plants had been distributed. These were propagated and planted with such energy that at the end of six years it is estimated that 1,000 acres had been devoted to Ceará rubber.

The first attempts to exploit the tree were strikingly disappointing, and it became generally stated that its cultivation was not remunerative.

The vicissitudes which the exploitation of this tree in Ceylon has undergone are well demonstrated by the fact that although 1,000 acres were planted with Ceará rubber in 1883, this area had dwindled down to 500 acres in 1903, and by the following records of the amount of rubber exported during various years :—

1892	...	...	...	...	...	7,280 lb.
1895	...	...	...	...	...	1,753 „
1896	...	...	...	...	...	17,591 „
1898	...	...	...	...	...	2,792 „

In 1905, on a Ceylon estate, situated some 2,000 feet above sea-level, a planter tapped 20 trees, the age of which was not recorded, and obtained 22 lb. of dry rubber which was valued by a Colombo broker at

4·60 rupees (6s. 1½d.) per lb. (*Journal d'Agriculture Tropicale*, No. 49, 1905, p. 196). Samples of Ceylon-grown Ceará rubber were shown at the Ceylon Rubber Exhibition held in September last, and were considered by the judges to be of better quality than any specimen of Pará rubber in the Exhibition ("Lessons of the Rubber Exhibition," *Ceylon Observer*, Sept. 28, 1906, p. 1503).

The Cereá tree was introduced into India in the same year as into Ceylon. In Mysore, South India, it flourished and reproduced itself so rapidly that it was considered a troublesome weed in some districts, and the greater part of the plants were uprooted. Later, when the price of rubber advanced, attention was devoted to the remainder (extract from *Madras Weekly Mail*, quoted in *The India Rubber Journal*, April 9, 1906, p. 406).

It was found that the trees yielded very little rubber during the first 7 years of their existence, but after 12 to 15 years *some* trees gave satisfactory returns. Recently 3 to 7 lbs. of dry rubber have been collected from individual trees.

One tree 15 to 16 years of age was tapped with a view of ascertaining the total amount of rubber which it would furnish, and 7 lb. of dry rubber were obtained. It is stated that this tree suffered no ill effects from the operation, but another tree which yielded a similar amount of rubber died from the wounds inflicted during tapping (*Tropical Life*, November, 1906, p. 166).

Rubber from a Mysore estate was classed by London brokers as equal to the best plantation Pará produced in Ceylon and the Straits Settlements, and was valued at 6s. to 6s. 1d. per lb. (*India Rubber Journal*, April 9, 1906, p. 406).

On an estate at 3,000 feet elevation in South Wynaad, 400 trees gave 170 lbs. of dry rubber, the work of tapping being carried out by inexperienced coolies, and it was considered that a methodical exploitation of the trees would have produced an average of 1 lb. of dry rubber per tree (*The Ceylon Rubber Exhibition—Lectures and Discussions on Rubber Cultivation and Preparation*, Ferguson, Ceylon, p. 12).

The climate of the Malay Archipelago appears to be too damp for the successful cultivation of *M. Glaziovii* (*Selected Papers from Kew Bulletin*, III. "Rubber," p. 125).

Some Ceará trees planted in 1900 in Maui, one of the Hawaiian group of islands, have grown well, and it is stated that as much as 1½ lb. of dry rubber has been obtained from a tree in one year (*Tropical Life*, November, 1906, p. 165).

Some experiments which were conducted under Mr. Johnson's supervision on 12-year-old Ceará trees in the Gold Coast showed that the value of the rubber obtained did not pay for the cost of collection (*Report on Rubber in the Gold Coast and Sierra Leone*—Colonial Reports, Miscellaneous, No. 28, 1904, p. 6).

In the French Congo 2,000 adult trees tapped by 35 workers yielded 95 kilos. (209 lbs.) of rubber at a cost of 5·24 francs per kilo. (2·2 lbs.), and the majority of the trees died afterwards. From a similar experiment in the same region only 28 grammes of rubber per tree were obtained (*Journal d'Agriculture Tropicale*, No. 61, 1906, p. 196).

In Angola an experimenter claims to have collected 215 grammes (7·6 oz.) of dry rubber from a tree aged 7 years in six tappings; in two subsequent tappings this tree gave an additional 58 grammes, which brings the total yield up to 273 grammes (9·6 oz.) (*Journal d'Agriculture Tropicale*, No. 64, 1906, p. 317).

Two trees planted in 1898 at Conakry, French West Africa, gave 222 grammes (7·8 oz.) of rubber (dry?) on being tapped in December, 1903 (*Journal d'Agriculture Tropicale*, No. 31, 1904, p. 31).

At Zoa in the Shiré Highlands of the Nyasaland Protectorate four trees, 10 to 12 years of age, were tapped three times, and yielded an average of 155 grammes (5·5 oz.) of dry rubber per tree, but this experiment was not completed (*Journal d'Agriculture Tropicale*, No. 41, 1904, pp. 330-1).

At Lewa in German East Africa 4,000 trees, 5 years of age, were tapped three times in 1903, and gave an average of 125 grammes (4·4 oz.) of rubber per tree *Journal d'Agriculture Tropicale*, No. 34, 1904, p. 126).

Eight-year-old trees in Quelimane, Portuguese East Africa, were tapped in 1902, and the maximum yield per tree was only 60 grammes (2·1 oz.) (*Journal d'Agriculture Tropicale*, No. 17, 1902, p. 343).

It was concluded, from an experimental tapping conducted on mature trees in Natal, that the value of the rubber obtained did not compensate for the cost of collection (*Profitable Agricultural Industries*, by J. Medley-Wood, p. 3. Reprinted from the *Natal Agricultural Journal*).

A tree 8 or 9 years of age in Inhambane, Portuguese East Africa, tapped in 1901, is reported to have given 260 grammes (9·2 oz.) of scrap rubber (*Journal d'Agriculture Tropicale*, No. 7, 1902, p. 8), while from the same district 96 trees of unrecorded age gave 284 grammes (10 oz.) of dry rubber per tree (*Journal d'Agriculture Tropicale*, No, 63, 1906, p. 263).

The foregoing records seem to indicate that, except in one or two instances, profitable results have not been obtained from the cultivation of the Ceará tree. Still, it should be borne in mind that the Pará rubber tree was largely cultivated for a considerable period before a satisfactory method of tapping was discovered, and it is therefore quite possible that when the tapping of Ceará trees has been more carefully and generally studied better results will be forthcoming.

The fact should not, however, be lost sight of that experimenters, in nearly every country where the tree is cultivated, seem to be unanimous in stating that the yield of rubber from different trees of a given age, growing under identical conditions, varies in a most extraordinary manner. One tree may give returns equal to Pará trees of similar age, whereas another will furnish practically no rubber, and the produce of other trees varies between these two extremes. It is therefore clear that the tapping of the tree is not the only matter which requires investigation, and there is little doubt that more care is necessary in selecting seeds from proved varieties for cultivation.

THE CEARÁ RUBBER TREE IN THE MOZAMBIQUE COMPANY'S TERRITORY.

The Ceará rubber tree appears to have been first introduced into Manica and Sofala in 1895. To-day there cannot be less than 75,000 trees planted in different parts of the Territory. The largest plantations

are those of (1) the Guara-Guara and Massanzane Estates Company on the banks of the Buzi river, containing some 10,000 trees varying in age from 2 to 9 years; (2) the Mozambique Company's plantation at Chibabava, which contains 7,500 trees, 1 to 5 years of age; (3) the Buzi Company's plantation of 7,000 trees, aged 5 to 9 years; and (4) various plantations in the Sena district, the majority of which are the property of the Mozambique Company, containing 30,000 trees, 3 to 6 years old.

The tree flourishes in every portion of the territory. It has been observed growing in many different soils and at elevations varying from sea-level to 5,000 feet.

Some planters complain that many of their trees have been damaged by wind, but this is not surprising considering that the wood of the Ceará tree is of brittle character, that its roots are principally produced near the surface, and that no attempt appears to have been made to plant windbreaks in the shape of belts of trees less susceptible to be affected in this manner.

Reports with regard to the amount of rubber produced are not very encouraging, but this is doubtless due to ignorance of the best methods of extracting the rubber, and to the tapping of immature trees.

In 1903 the Chefe of the Sena district exported 22 kilos. (48·4 lb.) of Ceará rubber collected from the Mozambique Company's Ceará trees in his district, and, in 1905, 500 kilos. (1,100 lb.) of Ceará rubber were collected from trees 4 to 5 years old growing in the Gorongoza district.

No systematic experiments appear to have been conducted, previous to Mr. Johnson's arrival, to ascertain the amount of rubber that the Ceará tree is capable of producing in the Mozambique Company's territory.

At Mandigos in December, 1906, Mr. Johnson obtained 180 grammes (6·3 oz.) of rubber by two tappings of four Ceará trees, 5 years of age, growing near the Commando. He is convinced that this yield would have been considerably increased had the experiment been continued, as the latex was still flowing abundantly when he left. The dry rubber was of good quality, very similar in appearance to the biscuits prepared from cultivated Pará trees.

In January, 1907, Mr. Johnson tapped on three consecutive days a 5-year-old tree growing in the Chibabava plantation, and obtained 69 grammes of dry rubber. He was informed that 8·5 grammes of dry rubber had been extracted from this tree a month previous to his arrival, so that the total yield of rubber in two months was 77·5 grammes (2·7 oz.). The latex was abundant, and a much larger yield of rubber would undoubtedly have been obtained had the experiment been continued. The Chefe of Mossurize, who visited Chibabava recently, reports that the incisions made in this tree have completely healed, and that it has not suffered from the tapping.

From a Ceará tree, 7 years old, growing on the Maruma estate, Mossurize, 80 grammes (2·8 oz.) of dry rubber were extracted in two consecutive days' tapping without diminishing the flow of latex. The rubber collected at Chibabava and Maruma was similar to that obtained at Mandigos.

EXPERIMENTAL TAPPING OF CEARÁ TREES AT GUARA-GUARA.

A series of tapping experiments under Mr. Johnson's supervision was commenced on the Ceará rubber trees growing on the estate of the Guara-Guara and Massanzane Estates Company at Guara-Guara, by permission of the Directors.

It was considered that the best period to test the trees was the end of the rainy season, *i.e.* the end of April or the beginning of May, as the latex should then be active, but the experiments were unfortunately delayed until the end of May. The reason for conducting the experiments on this estate was that it contains a larger number of mature trees than any other in the Territory.

The Guara-Guara estate is probably less than 100 feet above sea-level, and is situated on the left bank of the river Buzi about 40 miles from the port of Beira (lat. 19° 50′ 10″ S.; long. 34° 50′ 30″ E. Greenwich).

The soil is a deep fertile sandy loam, and the average annual rainfall probably similar to that of Beira, which during the five years August 1901 to July 1906 was 52·311 inches.

The estate is 5,000 hectares (about 12,500 acres) in area; it was established in 1895, but was transferred in 1900 to the present owners, who unfortunately are unable to furnish any records in regard to the age of the Ceará trees.

It was estimated that the trees selected for tapping varied from 7 to 9 years of age. They are planted about 4·80 m. x 4·80 m. (15 feet 9 inches) apart, or about 175 trees to the acre.

The plantation is stated to have been much neglected, having had practically no attention beyond an annual weeding, while with a view to preventing damage by wind many of the trees have had their branches cut back to the old wood once a year. A large number were noticed showing signs of having been maltreated in this manner on five or six different occasions.

Considering the manner in which these trees have been treated it is not surprising that they have not made very satisfactory growth. The majority of the trees commenced to branch at about six feet from the ground, some giving rise to numerous spreading branches, whereas others have more erect and fewer branches; the form of the latter trees resembles an inverted pyramid.

These two types of tree have been distinguished by some observers as "Pleureur" and "Candélabre," and described as "bad" and "good" rubber producers respectively (*Journal d'Agriculture Tropicale*, No. 41, 1904, p. 329; No. 49, 1905, p. 195). Some hundreds of trees of each type were tested at Guara-Guara, but the results obtained do not support this view.

It has also been frequently stated that the quality of the latex of different Ceará trees may be ascertained from the number of leaf lobes, but this character was found to be of no value for the purpose at Guara-Guara, as leaves with 3, 5, 7 and even 9 lobes were repeatedly noticed on the same tree.

One hundred and ten trees were selected for experiment, but before these were chosen eight trees were discarded as they were found to contain latex destitute of caoutchouc. This latex is usually pale brown, whereas the latex containing caoutchouc is milky white. It was impossible to coagulate the former by any of the methods usually adopted to bring about the coagulation of rubber latex, such as the application of heat or the

addition of acids. On being left exposed to the atmosphere for several days it solidified into a brittle, resinous substance devoid of elastic properties.

The outer bark of all the eight trees which yielded no rubber was much thicker than that of the trees which produced caoutchouc-containing latex, and, although much fissured, it exhibited less tendency to scale off.

A large number of trees with thick fissured bark were examined, and it was found in practically every instance that the latex produced contained no trace of caoutchouc. It would, however, be erroneous to assume that, because a particular Ceará tree has thin scaly bark, rubber is obtainable from its latex, as several instances have been observed by Mr. Johnson of trees which yielded latex rich in caoutchouc when they were first tapped, but afterwards produced worthless latex, and in one or two cases he has also found both good and bad latex exuding from different portions of the trunk of the same tree.

The quantity of latex produced by different trees of apparently similar age and size, growing under like conditions, and tapped in a similar manner, varies in a most extraordinary manner.

The general objects in view in conducting these experiments were, firstly, to endeavour to ascertain whether sufficient rubber could be extracted from the trees to allow of their being profitably cultivated in this Territory, and, secondly, to determine the method of tapping which would furnish the maximum yield of rubber, while at the same time causing the minimum amount of damage to the tree.

Some of the largest and best-formed trees were chosen for experiment, and as it is estimated that their ages varied from 7 to 9 years, it would, in Mr. Johnson's opinion, be perfectly reasonable for the purpose of this report to put the average age of the trees at 8 years. The average circumference of the trees taken at a metre (39·37 inches) from the ground was 75·24 cm. (29·62 inches), the largest circumference at this height being 1·13 m. (44·49 inches), and the smallest 60 cm. (23·62 inches).

The 110 selected trees were divided into 19 groups, each consisting of 5 trees, with the exception of group No. XIII., which contained 20 trees.

The trees in each group were treated in a different manner, variations being made either in the mode of tapping or in the time which was allowed to elapse between successive tappings.

Fifteen of the tapping implements, which have proved most successful for tapping rubber-producing trees in different parts of the world, were tested with a view of ascertaining the type of instrument best adapted for exploiting the Ceará tree. The following is a list of the implements used :—

(1) Christophe tapping-knife; (2) Michie-Golledge tapping-tool (small and large sizes); (3) Macadam comb-pricker; (4) Bowman-Northway puncturing-tool; (5) Macadam-Miller tapping-knife; (6) Macadam paring-chisel; (7) Holloway's tapping-knife; (8) Pull-and-push tapping-knife; (9) Viper tapping-knife (short and long patterns); (10) Bowman-Northway plane No. 1; (11) Bowman-Northway parer No. 2; (12) Tree pruning-knife, and (13) the Patent V.D.K. tapping-instrument.

It was not found practicable to tap the trees successfully with any one of these implements until the outer bark had been removed. It was also found that unless this course were adopted, a large amount of the latex which exuded from the incisions flowed down between the two layers of bark, and was difficult to collect. Fortunately, the outer bark consists of dead tissues, and can be easily removed by making a longitudinal incision through it on one side of the trunk, reaching as high as it is desired to operate, and then peeling it off in transverse strips.

Although the outer bark is rarely thicker than $\frac{1}{50}$th of an inch, it is so hard and coriaceous that it rapidly turns the edge of the tapping implements employed. In one or two cases where the first incisions were made after a good deal of labour without its removal, the portion nearest the incision commenced to peel off of its own accord after a few days.

The living bark immediately below the outside coriaceous layer is of bright green colour striped with white, but it was occasionally observed that certain trees had large pale yellow unhealthy-looking blotches. Whether this latter character is due to disease cannot yet be definitely stated, but in nearly every instance it was found that these areas furnished far less latex than the green-coloured portions.

The experiments showed that the flow of latex was far greater before sunrise and after sunset than during the day, and on cloudy days than when the sun was shining brightly. The yield of latex was also much greater from trees tapped in the early morning than from those tapped by a similar method in the evening. This fact will be seen by comparing the figures in Table I on pages 30, 31, shewing the amount of

latex yielded by the trees in Groups II*a* and I*b*, which were tapped in the morning, and that from Groups VII and VIII respectively, which were tapped in the evening with the view of demonstrating this point. This phenomenon is probably accounted for by the pressure of the sap in the plant vessels being greater in the morning, as less water vapour is transpired by the plant during the night, when the temperature is usually much lower than during the day.

In tapping the Pará rubber tree, it is almost invariably found that the maximum yield of latex is not obtained from the first incisions. Frequently the greatest flow of latex does not occur until after the twelfth tapping, but usually it takes place after the seventh or eighth tapping.

It is generally considered that this characteristic behaviour, which is commonly known as "wound response," is due to a flow of latex towards the injured part for the purpose of repairing the damage inflicted by the tapping.

The Ceará trees at Guara-Guara were not found to behave in this manner, as out of thirteen groups of trees, six yielded the greatest amount of latex from the first tapping, three from the second, and four from the third. In four of the groups the trees were first tapped on one side and then on the other side of the trunk, and all, with a single exception, yielded the greatest amount of latex from the first incisions.

The effect of tapping on the Ceará trees at Guara-Guara was therefore contrary to that observed in the case of Pará trees. The initial tapping seemed to drain the latex from a fairly large area near the incision, and when repeated by excising a thin shaving from the lower side of the wound scarcely a trace of latex exuded. All the vessels near the edge of the wound appeared to be completely denuded of moisture of any description, and a much thicker shaving of bark had to be removed than is necessary in re-tapping Pará trees. Further, this dried-up tissue is exceedingly difficult to tap, being far more brittle than the bark which has its cells distended with moisture.

The bark of the Ceará tree is much thinner than that of the Pará tree even if measured before the leathery rind is removed. The tappable portion of the bark of the former, after removal of the external layer, was observed to vary in thickness from $\frac{1}{16}$th to $\frac{3}{16}$ths of an inch (1·5 to 4·5 mm.), but the average thickness was a mean between the two, viz., $\frac{1}{8}$th of an inch (3 mm.). The bark of the Pará tree usually varies in thickness from $\frac{1}{8}$th to $\frac{1}{2}$ inch (3 to 12·5 mm.).

Much greater care has therefore to be exercised in the tapping of the Ceará tree in order to avoid damaging the cambium tissue, which is situated between the bark and the wood and from which new tissues are formed.

The experiments at Guara-Guara seem to indicate that it will not be possible to tap the Ceará tree as extensively as the Pará tree.

Frequent instances were noticed by Mr. Johnson in which the layer of cambium tissue exposed by the tappers had commenced to dry and peel off, leaving the wood bare. Such wounds will require months, and in exceptional cases perhaps years, before they thoroughly heal. It is, however, only fair to point out that the operations at Guara-Guara were commenced with unskilled kaffirs, who had never seen a rubber tree tapped in a proper manner, the only method known to them being that usually employed in extracting rubber from the indigenous *Landolphia*, which consists in slashing off huge slices of bark and wood with crude bush-knives. Their work was, however, vigilantly supervised, and careless tapping was by this means prevented as much as possible.

The bark of several trees, which in Mr. Johnson's opinion had not been too severely tapped judging by the methods employed in exploiting other rubber-producing trees, commenced to decay, and on closer examination it was found that the cambium tissue seemed to be in an unhealthy condition. This, however, was not observable until the trees had been tapped several times. In nearly every case the decay appeared to be coincident with the unhealthy-looking blotches in the bark, the existence of which has been previously referred to. If the assumption that the appearance of this tissue is due to disease be correct, it follows that the decay may not be altogether due to excessive excision of the bark.

As will be explained later the bark was not excised from the trees in Groups XI and XII, but rings of pricks 33 cm. (13 inches) apart, one below the other, were made in the bark on alternate days, and the rubber collected in the form of "scrap." After the eleventh pricking very little latex exuded, and as the bark of several trees commenced to develop a brown unhealthy appearance in and around the pricked areas the work was abandoned.

In each experiment the tapping was immediately abandoned when a tree exhibited signs of exhaustion or upon the slightest indication of decay.

In the tapping of Pará trees it is found that by alternately shaving and pricking the lower surface of the wound a far greater yield of latex is obtained for the amount of bark excised than if the pricking method were not adopted. In the case of the Ceará trees at Guara-Guara, however, it was found that the surfaces of the wounds dried up too much for an appreciable yield of latex to be obtained by pricking them.

The latex of the Ceará tree is thicker than that of the Pará tree, and very rarely requires any treatment to induce coagulation, in fact great difficulty was experienced in preventing the separation of the rubber from the latex before collection. Even when a strong solution of ammonia was added coagulation was not appreciably checked.

The latex from the spiral and herring-bone incisions was collected by placing cups on the ground at the base of each incision. It was found that the flow of latex into the collecting cups is considerably facilitated if a small trough cut out of the leathery outer rind, which is peeled off the tree previous to tapping, is inserted at the base of each incision.

Both enamelled iron and lead-covered collecting cups were employed, but as the former have a smoother surface, less difficulty was experienced in collecting the latex from them.

With a view to retarding the coagulation of the latex in the collecting cups, solutions of formaldehyde, varying in strength from 1 to 5 per cent., were placed in the cups, but, although coagulation was delayed to a certain extent by this treatment, it was not completely checked previous to the collection of the latex in any one instance. In fact a strong solution of formaldehyde, which was erroneously placed in one set of collecting cups, caused almost immediate coagulation.

The latex collected on certain days was treated with a 1 per cent. solution of creosote with the view of antisepticising the rubber, and this addition caused almost immediate coagulation.

Certain samples of the rubber were submitted to the smoke and heat given off by wood fires, in order to enable a comparison to be made between rubber thus cured and that obtained by other processes.

A full account of the various methods employed (1) to retard the coagulation of the latex in the collecting cups, (2) to hasten the coagulation of the latex after collection, and (3) to cure the rubber, will be given

in a succeeding report after the various samples have been examined at the Imperial Institute.

A detailed description of the various methods of tapping employed and the yield of rubber obtained therefrom is given in Table I on pages 30, 31.

Except where otherwise stated the outer rind was peeled off the trunk up to a height of 2 metres (6 feet 6 inches) from the ground before tapping.

PERCENTAGE OF RUBBER IN THE LATEX.

The percentage of rubber in the latex varied in a most extraordinary manner from day to day and from different groups of trees, but on comparing the yield of rubber obtained from the total amount of latex collected from each group of trees the variation is not so striking. As shown in Table II on page 32, the highest percentage of rubber in the latex (24 per cent.) was given by the trees in Group I*b*, whilst the lowest (16·4 per cent.) was furnished by the trees in Group II*a*. The percentage of rubber produced from the total amount of latex collected was 19·07 per cent.

YIELD OF RUBBER COMPARED WITH THE AMOUNT OF BARK EXCISED.

It has been previously mentioned in this report that the best method of tapping is that which extracts the greatest amount of latex and causes the least damage to the tree.

Except in the case of the trees in Groups XI and XII, the general principle of the tapping methods employed at Guara-Guara was first to excise, from different parts of the two metres of trunk nearest the ground, strips of bark about $\frac{1}{4}$ inch wide, and varying in depth in proportion to the thickness of the bark of the tree operated upon, so as not to injure the cambium layer.

The subsequent operations consisted in shaving off thin layers of bark from the lower side of the initial incisions, excepting, of course, the perpendicular channels made to convey the latex from the transverse incisions in the so-called "herring-bone" method of tapping.

As uniform care was taken to prevent damage to the cambium tissue throughout each series of experiments, it may be reasonably assumed that the most destructive method of tapping was that which necessitated the excision of the largest area of bark, and the best method that which furnished the greatest amount of rubber proportionate to the area of bark excised.

Table II. on page 32 gives the average area of bark excised per tree, the yield of rubber per tree, and the average yield of rubber per 100 sq. cm. of bark excised from the trees in each group.

On consulting this table it will be found that the best results were obtained from Group III*a*, which yielded 27·77 grammes of rubber for every 100 sq. cm. of bark removed, and the worst from Group IV*b*, which only yielded 4·26 grammes of rubber by the removal of the same amount of bark.

It is, however, too early to state definitely which method of tapping will eventually produce the most successful results, but it is proposed to obtain a satisfactory solution to this problem before the second part of this report is issued.

TAPPING IMPLEMENTS.

Of the various implements tested for making the "spiral" and "herring-bone" incisions, the "Christophe" tapping-knife, with guide removed, proved most satisfactory for making the initial cuts. The guide supplied with this knife is supposed to regulate the depth of the incision, and thus to prevent damage to the cambium, but, as it only seemed to confuse the tappers, it was discarded. For subsequent shaving operations, the "Michie-Golledge" rubber-collecting tool, small size, was found to be the most suitable.

Both of these instruments are easily manipulated. Every part of the former is made of metal, and it is provided with three interchangeable blades, which are held in position by screws. The only part of the knife likely to be easily put out of working order is the cutting edge, which requires constant sharpening if careful tapping is to be carried out. The shaving instrument is in the form of a bevelled chisel, and is admirably adapted for shaving off fine layers of bark from the side of the wound, but like the former it requires constant sharpening.

TABLE I.

Experiment.	Method.	Average yield of latex per tree.		Average yield of "biscuit" rubber per tree.		Average yield of "scrap" rubber per tree.		Total average yield of dry rubber per tree.	
		c.c.	*fl. ounces.*	*grammes.*	*ounces.*	*grammes.*	*ounces.*	*grammes.*	*ounces.*
I*a*.	Five trees: ten tappings each. Full spiral system, incisions 30 cm (11·8 inches) apart; lower surface of wounds shaved every alternate day, with interval of eight days between the fifth and sixth tappings	304	10·72	53·3	1·88	36·5	1·29	89·8	3·17
I*b*.	Five trees: six tappings each. Method similar to I*a*, except that the wounds were shaved every fourth day	284	10·0	68·1	2·40	42·8	1·51	110·9	3·91
II*a*.	Five trees: ten tappings each. Method similar to I*a*, but only 25 cm. (9·8 inches) between the incisions	435	15·34	71·3	2·51	74·7	2·63	146·0	5·14
II*b*.	Five trees: seven tappings each. Method similar to II*a*, but wounds shaved every fourth day	286	10·09	59·1	2·08	51·2	1·81	110·3	3·89
III*a*.	Five trees: ten tappings each. "Herring-bone" incisions on one side of trunk, 33 cm. (13 inches) between each transverse incision; wounds shaved every second day, but interval of eight days between the fifth and sixth tappings	556	19·61	108·4	3·82	65·9	2·32	174·3	6·14
III*b*.	Five trees: seven tappings each. "Herring-bone" incisions on each side of tree, transverse incisions 33 cm. apart; wounds shaved every fourth day	306	10·79	66·9	2·36	66·1	2·33	133·0	4·69
IV*a*.	Five trees: thirteen tappings each. One side of tree tapped with "herring-bone" incisions 23 cm. (9 inches) apart; wounds shaved every second day; after fifth tapping the opposite side of the tree was similarly treated, leaving the side first tapped to rest	385	13·58	83·6	2·95	58·5	2·06	142·1	5·01
IV*b*.	Five trees: seven tappings each. "Herring-bone" incisions 23 cm. apart on both sides of trunk; wounds shaved every fourth day	181	6·39	36·0	1·27	24·7	0·87	60·7	2·14
V*a*.	Five trees; nine tappings each. "Herring-bone" incisions 33 cm. (13 inches) apart on both sides of trunk; wounds shaved every second day	242	8·55	52·3	1·85	47·2	1·66	99·5	3·51
V*b*.	Five trees: six tappings each. Method similar to V*a*, except that wounds were shaved every fourth day	254	8·96	46·1	1·62	25·1	0·89	71·2	2·51
VI*a*.	Five trees: nine tappings each. Method similar to V*a*, except that transverse incisions were 23 cm. (9 inches) apart, and that trees were rested for eight days between the fifth and sixth tappings	242	8·55	39·9	1·41	7·7	1·33	77·6	2·74

VI*b*.	Five trees: six tappings each. Method similar to VI*a*, except that wounds were shaved every fourth day	210	7·41	34·9	1·23	39·5	1·39	74·4	2·62
VII.	Five trees: six tappings each. Method similar to II*a*, but tapped during evening to compare flow of latex with that during morning	131	4·62	23·2	0·82	47·7	1·68	70·9	2·50
VIII.	Five trees: six tappings each. Method similar to I*b*, but tapped during evening to compare flow of latex with that during morning	315	11·11	56·2	1·98	109·7*	3·87*	165·9	5·85
IX.	Five trees: eleven incisions each. Rind taken off one side of trunk and herring-bone" incisions made 33 cm.(13 inches) apart wounds shaved every second day. After the fifth tapping the opposite side of the trunk was treated similarly, and the side first tapped allowed to rest	337	11·89	56·1	1·98	74·9	2·64	131·0	4·62
X.	Five trees: eleven tappings each. Method similar to IX., but incisions only 23 cm. (9 inches) apart	332	11·71	59·5	2·10	56·9	2·01	116·4	4·11
XI.	Five trees eleven tappings each. Rind taken off one side of trunk and six half rings made with "Macadam's Comb-Pricker about 33 cm. (13 inches) apart; on every second day similar incisions were made immediately below the previous ones. After the fifth tapping the opposite side of the trunk was similarly treated and the side first tapped rested	† —	—	—	—	—	—	147·7	5·21
XII.	Five trees: eleven tappings each. Rind taken off trunk up to 2 metres (6.61 feet); six rings of pricks made with "Bowman-Northway Pricker" about 33 cm. (13 inches) apart; on every second day similar incisions were made immediately below the previous ones	† —	—	—	—	—	—	138·5	4·88
XIII.	Twenty trees: twelve tappings each. Rind taken off one side of tree; single perpendicular channel made from base to a height of 2 metres in the extreme left edge of the exposed bark; transverse incisions 33 cm. apart, each extending about one-third round trunk made in exposed bark leading into the perpendicular channel; lower side of transverse cuts shaved every second day. After fifth tapping the first tapped area was rested and rind taken off opposite side of trunk; similar incisions alternating with first series were made, leading into perpendicular channel; wounds shaved every second day. About one-third of trunk left untapped	271	9·56	51·9	1·83	26·0	0·92	77·9	2·75

* One tree is estimated to have furnished quite half the total amount of "scrap" rubber collected from these five trees.

† The whole of the rubber obtained in these two experiments (XI and XII) was collected in the form of "scrap."

TABLE II.

Experiment.	Quantity of latex obtained from five trees.	Quantity of dry rubber from latex.	Percentage of dry rubber to latex.	Total average yield of dry rubber per tree.	Average amount of bark excised per tree.	Average yield of dry rubber per 100 sq. cm. of bark excised.
	c.c.	*grammes.*		*grammes.*	*sq. cm.*	*grammes.*
I*a*.	1520	266·5	17·5	89·8	1676·4	5·36
I*b*.	1418	340·5	24·0	110·9	984·9	11·26
II*a*.	2175	356·5	16·4	146·0	1594·4	9·16
II*b*.	1430	295·5	20·7	110·3	1234·3	8·94
III*a*.	2780	542·0	19·4	174·3	627·6	27·77
III*b*.	1530	334·5	21·9	133 0	1537·7	8·66
IV*a*.	1926	418·0	21·7	142·1	1447·4	9·82
IV*b*.	905	180·0	19·9	60·7	1424·8	4·26
V*a*.	1210	261·5	21·6	99·5	1444·2	6·89
V*b*.	1270	230·5	18·1	71·2	1153·3	6·17
VI*a*.	1212	199·5	16·5	77·6	1564·7	4·96
VI*b*.	1051	174·5	16·6	74·4	972·7	8·06
VII.	655	116·0	17·7	70·9	956·6	7·41
VIII.	1575	281·0	17·8	165·9	984·9	16·84
IX.	1685	280·5	16·7	131·0	1765·1	7·42
X.	1660	297·5	17·9	116·4	1912·4	6·09
XIII.	5420*	1038·5	19·2	77·9	855·9	9·11
Average figures from the results for 100 trees	—	—	19·07	108·94	—	9·3

* Latex from twenty trees.

YIELD OF SCRAP RUBBER.

A striking feature of these experiments is the abnormally large percentage of "scrap" rubber collected.

The comparative yields of scrap and biscuit rubber from each group of trees are given in Table I., on pages 30, 31, and show that Groups VII. and VIII. produced nearly twice as much scrap as biscuit rubber, whilst three other groups yielded more scrap than biscuit rubber. The large yield of scrap rubber from Groups VII. and VIII. is, however, partly accounted for by the fact that the trees were tapped in the evening when the latex is considered to be thicker and therefore more liable to form scrap rubber, as it flows less freely and consequently coagulates more readily.

The production of scrap rubber could doubtless be considerably diminished by the employment of "drip tins," or a similar arrangement, which would provide a slow continuous flow of water along the excised surface of the wounds to flush the exuding latex down into the collecting cups. It is also probable that the adoption of such a system would materially increase the yield of rubber, for it was frequently observed that the latex on issuing from the excised surface coagulated and closed up the wounds, thus checking any further flow.

The bark shavings also contained a small quantity of scrap rubber, and it was found that its collection was considerably facilitated by soaking the shavings in water for a few hours.

ANTICIPATED YIELD AND PROFITS.

Although it is considered inadvisable to enter into details in this part of the report respecting the profits likely to accrue to the cultivator of the Ceará rubber tree in the Mozambique Company's territory, a brief summary of the results already obtained will probably be acceptable.

In any case it will be readily understood that it would be impracticable to base the cost of collection and preparation on a series of small experiments. The ultimate results can only be satisfactorily stated

when the effect of the different methods of tapping on the trees has been ascertained, and the number and extent of the tappings possible in a year have been determined.

The total average yield of dry rubber per tree at present stands at 112·5 grammes (3·97 oz.), made up of "biscuit" and "scrap" in almost equal quantities.

As about 175 trees have been planted per acre, the total yield of dry biscuit and scrap rubber per acre is approximately 19·69 kilos. (43·42 lb.).

The general character of the rubber collected at Guara-Guara is very similar to Ceylon plantation Ceará, the London market prices for which in June last were about 4s. 11½d. to 5s. 7½d and 3s. 10¾d. to 4s. 2d. per lb for biscuit and scrap respectively. Taking a mean of these figures, the value of the rubber yielded per acre up to date at Guara-Guara is £10 2s. 7d.

If due consideration be given to the unfavourable conditions under which these trees have grown, and as it is anticipated that they may be tapped at least twice and possibly three times a year, the prospects of profitably cultivating the Ceará rubber tree in this territory are distinctly encouraging.

The following is the Report of the Director, Imperial Institute, London, on the rubber obtained as a result of these experiments :—

"The samples of Ceará rubber which are the subject of this Report were prepared by Mr. W. H. Johnson in the course of his experimental tappings of Ceará trees at the Guara-Guara and Massanzane Estates Company's Plantation, and were forwarded for examination to the Imperial Institute by the London Manager of the Moçambique Company with letter dated the 21st October, 1907.

Eleven samples of rubber prepared by slightly different processes were submitted and the following details were furnished regarding their preparation :—

No. 1 (2 biscuits). A solution of 1 per cent. ammonia placed in collecting cups.

No. 2 (2 biscuits). A solution of 2 per cent. ammonia placed in collecting cups.

No. 3 (3 biscuits). A solution of 2 per cent. ammonia placed in collecting cups. One per cent. solution of creosote added to latex.

No. 4 (3 biscuits). One per cent. solution of formaldehyde placed in collecting cups. Rubber smoked.

No. 5 (2 biscuits). Two per cent. solution of formaldehyde placed in collecting cups. Rubber smoked.

No. 6 (6 biscuits). Three per cent. solution of formaldehyde placed in collecting cups. Rubber smoked.

No. 7 (3 biscuits). Four per cent. solution of formaldehyde placed in collecting cups. Rubber smoked.

No. 8 (3 biscuits). Five per cent. solution of formaldehyde placed in collecting cups. Rubber smoked.

No. 9 (2 biscuits). Rubber smoked.

No. 10. Smoked "Scrap."

No. 11. "Scrap."

The unsmoked biscuits, Nos. 1, 2 and 3, were very similar in appearance. They consisted of thin biscuits of pale brown rubber, rather rough, and with white patches on the surface. The physical properties of all three samples were satisfactory.

The smoked specimens, Nos. 4, 5, 6, 7, 8 and 9, were all very similar in character. They were dark brown, but were otherwise superior to the unsmoked samples in appearance; they had a strong smoky odour. The physical properties of all the specimens were very satisfactory and no differences could be detected in this respect between the samples prepared with varying amounts of formaldehyde.

The scrap rubbers, Nos. 10 and 11, were of good quality, the only difference being that the smoked sample No. 10 was darker than the unsmoked scrap.

RESULTS OF EXAMINATION.

The following four samples, representative of the entire collection, were selected for analysis :—

No. 1. 1 per cent. solution of ammonia added to latex.

No. 3. 2 per cent. solution of ammonia and 1 per cent. solution of creosote added to latex.

No. 4. 1 per cent. solution of formaldehyde added to latex; rubber smoked.

No. 8. 5 per cent. solution of formaldehyde added to latex; rubber smoked.

The results of the examination of these samples are given in the following table :—

	Sample as received.				Composition of dry rubber.			
	No. 1.	No. 3.	No. 4.	No. 8.	No. 1.	No. 3.	No. 4.	No. 8.
Moisture, per cent....	1·9	2·9	0·6	1·7	—	—	—	—
Caoutchouc* ,, ...	82·9	80·5	85·1	83·1	84·4	82·8	85·6	84·6
Resin ,, ...	5·7	5·3	6·3	6·7	5·8	5·5	6·3	6·8
Proteids ,, ...	8·1	9·1	6·1	6·9	8·3	9·4	6·2	7·0
Ash ,, ...	1·4	2·2	1·9	1·6	1·5	2·3	1·9	1·6
* "Caoutchouc" insoluble in chloroform					1·0	1·6	0·7	0·2

It will be seen from a comparison of these figures that the four samples of Ceará rubber are fairly uniform in composition. The percentages of caoutchouc in the dry rubber show little variation in the case of Nos. 1, 4, and 8, whilst the amount in No. 3 is only slightly lower than in the other samples, owing to the presence of larger quantities of proteids and ash. All the specimens contained a small amount of "caoutchouc," insoluble or difficultly soluble in chloroform, the percentages of this constituent ranging from 0·2 in No. 8 to 1·6 in No. 3. The amounts of resin and ash vary a little in the different samples, but in no case are they excessive. The proteid figures are, however, a little high, especially in Nos. 1 and 3. It must be remembered, however, that ammonia was used in the preparation of samples Nos. 1 and 3, and this fact no doubt explains the higher percentage of nitrogen (from which the amount of proteid is calculated) found in these two cases. It may be noted further that No. 3,

in which 2 per cent. ammonia was employed, gave a higher result than No. 1, where only 1 per cent. solution of ammonia was used. Except for this variation in the proteid figures there is little difference between the results obtained for Nos. 1 and 3, and similarly Nos. 4 and 8, prepared with 1 and 5 per cent. solution of formaldehyde respectively, show only slight variation in composition.

It is not stated whether these different samples of rubber were all prepared from a bulked quantity of latex, so as to permit of direct comparisons being made between the different methods of preparation employed, or whether the samples represent the product of the separate groups of trees. The variations in the analytical figures are, however, such as would be likely to occur in specimens prepared from different trees.

The four samples examined are very satisfactory so far as chemical composition is concerned, and the results indicate that Ceará rubber of very good quality can be prepared in the territory of the Mozambique Company.

For comparison with the results obtained in the examination of these samples of Ceará rubber from Portuguese East Africa, the following figures giving the composition of Ceará rubber produced in Ceylon may be given.

		I.	II.	III.
Moisture	... per cent.	0·70	3·10	1·58
Caoutchouc	... ,,	92·58	87·97	86·14
Resin ...	... ,,	3·80	1·40	5·74
Proteids	... ,,	2·12	6·13	5·06
Ash ...	... ,,	0·80	1·40	1·48

These Ceylon samples show striking differences in the percentages of resin and proteids, but all of them are slightly superior in composition to the specimens from Portuguese East Africa.

COMMERCIAL VALUE.

In order to render this report complete the following valuations which were furnished with the samples are given. For comparison with the prices quoted it may be stated that fine hard Pará rubber from South

America was valued at 4s. per lb. on the same date, and fine plantation Pará at 4s. 7d. to 4s. 8½d. per lb.

No. 1 (two biscuits cured by 1 per cent ammonia solution in collecting cups).—Light and dark amber Ceará biscuits, rather rough and a little stained.

No. 2 (two biscuits, 2 per cent. ammonia).—About the same as No 1 but rather dull.

No. 3 (three biscuits, 2 per cent. ammonia and 1 per cent. solution of creosote).—Similar to above, but rather rough and scaly.

These three lots are of good quality and well prepared, and there is very little to choose between them; if anything we make No. 1 rather the best. Value 4s. 6d. per lb.

No. 4 (three biscuits, 1 per cent. of formaldehyde). Dark amber biscuits, good quality, but one biscuit slightly deadish; not properly cured. Value 4s. 6d. per lb.

Nos. 5, 6, 7, and 8. (Cured with 2, 3, 4, and 5 per cent. solution of formaldehyde placed in collecting cups). All good dark amber biscuits, well prepared, clear, clean and strong. Value 4s. 7d. per lb.

No. 9. (Two biscuits, smoke cured). A little rough, but apparently quite as good and well prepared as Nos. 5 to 8. Value 4s. 7d. per lb.

We consider that the smoked biscuits are better in appearance, and seem rather more resilient than the unsmoked. As to the effect on rubber of the use of ammonia and formaldehyde in various quantities, this would have to be decided by analysis, or on the reports of manufacturers, as the samples themselves show very little difference, whether mixed with 1 per cent. or 5 per cent.

No. 10. Good, clean, brown, smoked Scrap, free from heat and well cured. Value 3s. 6d. per lb.

No. 11. Pale Ceará Scrap, free from bark and heat, and of the usual quality of the grade. Value 3s. 4d., 3s. 5d. per lb.

CONCLUSIONS.

It is evident from the results of this investigation that Ceará rubber of very satisfactory quality and value can be produced in Portuguese East Africa. It now remains to be ascertained whether the yield of rubber obtainable by the use of improved methods of tapping will render the cultivation of the trees remunerative.

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Comm Francisco Felisberto Dias Costa

Rua Paschoal de Ellis 91-2º D.

Lisboa

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